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User Manual

QUICKMARQUEE

By Total Control Products, Inc.

TOTAL CONTROL

***QUICKMARQUEE DISPLAY* User Manual**
800-0300-013
Revision B

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Manual Design and Implementation by: Patrick Ward

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1. INTRODUCTION

1.1. INTRODUCTION

Marquee Displays can display alphanumeric messages received from a host. The host may be a Marquee Controller (SM1000SMC), programmable logic controller, computer, or a master Allen-Bradley Bulletin 2706 Dataliner DL20 display. Either RS232 or RS422/485 (multidrop) serial communication can be used. All message attributes and storage of messages is performed by the host.

Marquee Displays operate in a Slave mode. The slave mode allows up to 123 displays to have a unique address when using an RS422 network. Also, RS232 can be used. Serial commands are described later in this manual.

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1.2. DISPLAY CONFIGURATIONS

Catalog Number	Description			
	# of Lines	Chars./Line	Char. Height	LED Color
SM1202FOA	1	20	2"	RED
QM1104ROA *	1	10	4.8"	RED
	2	20	2.1"	
QM1204ROA *	1	20	4.8"	RED
	2	40	2.1"	
QM2204ROA *	2	20	4.8"	RED
	4	40	2.1"	
QM4204ROA *	4	20	4.8"	RED
	8	40	2.1"	
QM1104COA *	1	10	4.8"	TRICOLOR
	2	20	2.1"	
QM1204COA *	1	20	4.8"	TRICOLOR
	2	40	2.1"	
QM2204COA *	2	20	4.8"	TRICOLOR
	4	40	2.1"	
QM4204COA *	4	20	4.8"	TRICOLOR
	8	40	2.1"	

* Displays capable of 4.8" characters are also capable of twice as many lines and characters in a 2.1" character height.

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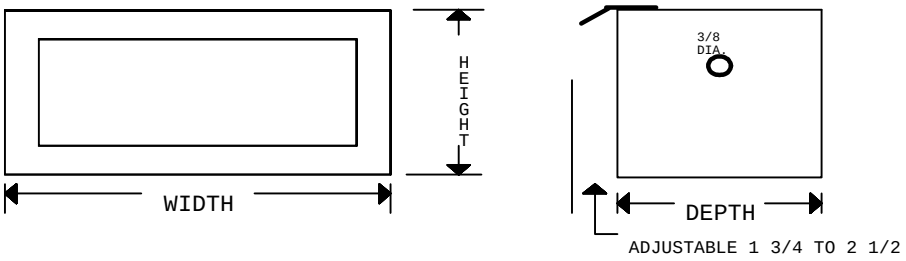
1.3. DIMENSIONS



Model	Height (inches)	Width (inches)	Depth (inches)	Weight (lbs)	Power Required
SM1202FOA	7-7/8	40-1/4	5-5/8	45	60 VA
QM1104ROA	8-1/4	45-1/2	5-1/2	50	100 VA
QM1204ROA	8-1/4	81-1/2	5-1/2	70	150 VA
QM2204ROA	15-1/8	81-1/2	5-1/2	100	300 VA
QM4204ROA	30-1/4	81-1/2	5-1/2	200	600 VA
QM1104COA	8-1/4	45-1/2	5-1/2	50	150 VA
QM1204COA	8-1/4	81-1/2	5-1/2	70	250 VA
QM2204COA	15-1/8	81-1/2	5-1/2	100	500 VA
QM4204COA	30-1/4	81-1/2	5-1/2	200	1000 VA

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1.4. SPECIFICATIONS

DISPLAY MEDIA

Type:	Contiguous LED matrix
Color:	Red or Tricolor (red, green & amber)
Viewing Range:	125 ft for 2.1" characters
	275 ft for 4.8" characters
Viewing Angle:	60° left/right/up/down
Display Life:	50,000 Hours

ELECTRICAL

Input Voltage:	115 VAC +/- 10%, 60 Hz
Input Power:	See table above.
Fuse Type:	3AG, See table above for rating.
Open-Collector Output:	5 to 24 VDC, 250ma, sinking
Communication:	RS232, RS422/485 (Addressable)
Baud Rate:	300, 1200, 9600, 19200

ENVIRONMENTAL

Operating Temperature:	0° to 55° C
Storage Temperature:	-40° to 85° C
Humidity:	5% to 95% non-condensing
Enclosure Type:	NEMA 12/4

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1.5. OPERATING TEMPERATURE

As listed above, the operating temperature of the display is 0° to 55° C. The display is capable of operating at these temperatures because of thermal management incorporated into its design. When operating at temperatures close to 55° C, the display will automatically dim itself to prevent it from overheating. If the internal temperature of the display exceeds 70°C, the unit will shut down and display OT at 5 second intervals until the internal temperature falls below 68°C. Since the dimming feature is based on the internal temperature of the display, the ambient temperature at which each stage of dimming occurs may vary between models. The dimming criteria is listed below.

Internal Temp. (°C)	Percent On	Dimming Effect
0 - 49	100%	None
50 -59	75%	Slight
60 - 64	50%	Noticeable
65 - 69	25%	Significant
70+	0%	Display “OT” only

At 75%, the dimming is very slight and hardly noticeable, however, as the internal temperature rises, the dimming becomes more noticeable. As the unit cools down, the display will automatically increase its brightness until back to 100%. A hysteresis is built into this feature to prevent any flickering effect.

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1.6. UNPACKING

No special precautions, other than careful handling, are required during unpacking the display. Care should be taken to avoid scratching the lens on the front panel.

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2. INSTALLATION

2.1. INSTALLATION

Marquee Displays are fully inspected and tested before leaving the factory. They are packed in specially designed cartons to protect them from damage during shipment. They should, however, be inspected upon receipt at the destination for visible or concealed damage. Claims for loss or damage should be filed with the carrier immediately. A claim for concealed damage is required when damage is not externally visible. Total Control Products will assist insofar as is practical in securing satisfactory adjustment of claims; however, all claims for loss and damage must be made by the purchaser to the carrier.

In the application of Total Control Products Marquee Displays, every precaution must be taken to provide a safe mechanical support system and proper electrical components for a safe electrical system. Local codes and ordinances governing wiring and installation practices must be observed.

In order to install your Marquee Display you must:

1. Survey the area where the display will be installed. Make sure that sunlight will not fall directly on the display surface since the LED characters will be washed out by direct sunlight. While the unit is rated as NEMA 12, it was not designed for continuous use under dripping liquids such as water pipes, condensation lines, or roof leaks.

2. Locate a source of 115VAC power and determine how you will route the power to the Marquee Display. Check the specifications tables for power requirements.

3. Decide if you will use RS232 or RS422 communications from the host and how you will route the cable to the Marquee Display.

2.2. MECHANICAL MOUNTING

This section describes the mechanical aspects of installing the Marquee Display. It is a good idea to test the display and set the dip switches before installing it. This can be done by installing a temporary power cord to the AC connections and attaching the host RS232/422 connections. Refer to the Section 3 for instructions on connecting AC power and host cables.

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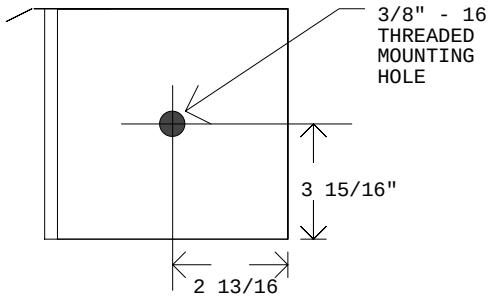
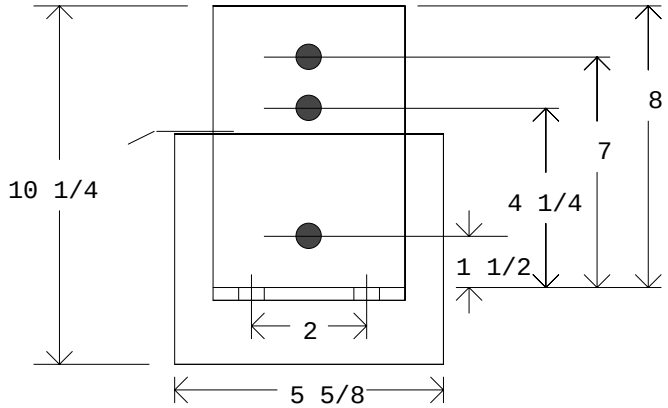
2.3. MARQUEE DISPLAY MOUNTING HOLE

The Marquee Display system was designed to be mounted in several configurations. There is a standard mounting hole in each end wall of the Marquee display. Each end wall is reinforced with a 4 inch square 12-gauge steel plate with a welded nut to accept a 3/8 - 16 inch bolt.



2.4. HANGING/WALL MOUNTING BRACKET

This bracket is an option which will allow hanging or wall mounting the Marquee Display. The bracket is shown below.



SM1000HWB

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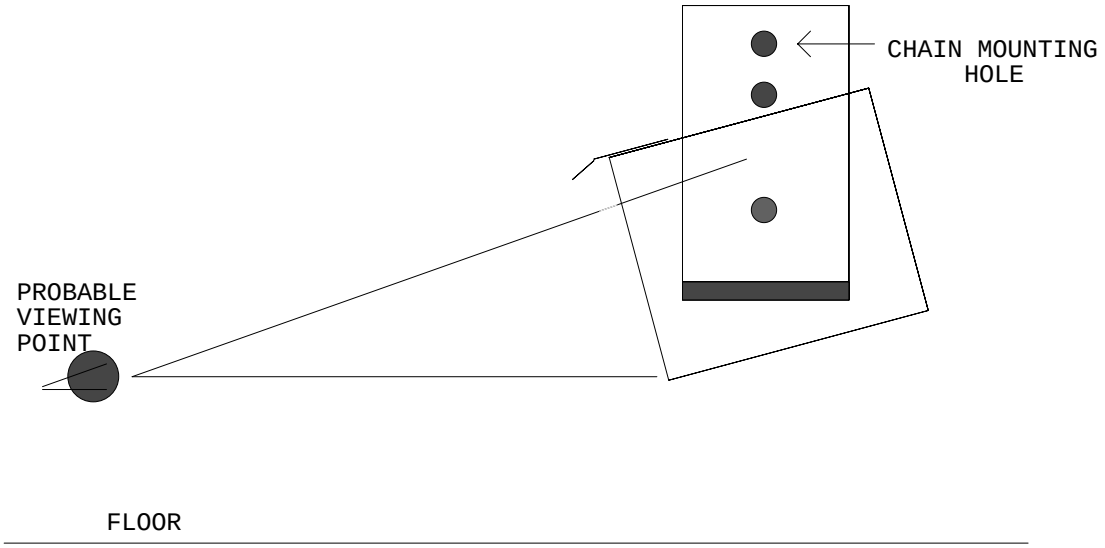
2.5. CHAIN SUSPENSION

To suspend the Marquee Display from a chain, use the Wall Mounting Bracket so that the display can be adjusted for the best viewing angle.

Mount the bracket so that the hole nearest the bend in the Mounting Bracket is used to attach the bolt to the threaded hole in the Marquee display end wall. Select the required viewing angle and tilt the bracket to desired angle and tighten bolt. Repeat the procedure for the other side.



Now the unit should be suspended with chains from the ceiling or building support structure. When selecting a mounting location be sure that there is sufficient support for your Marquee Display. Check the weight of your Marquee Display from the specification table.

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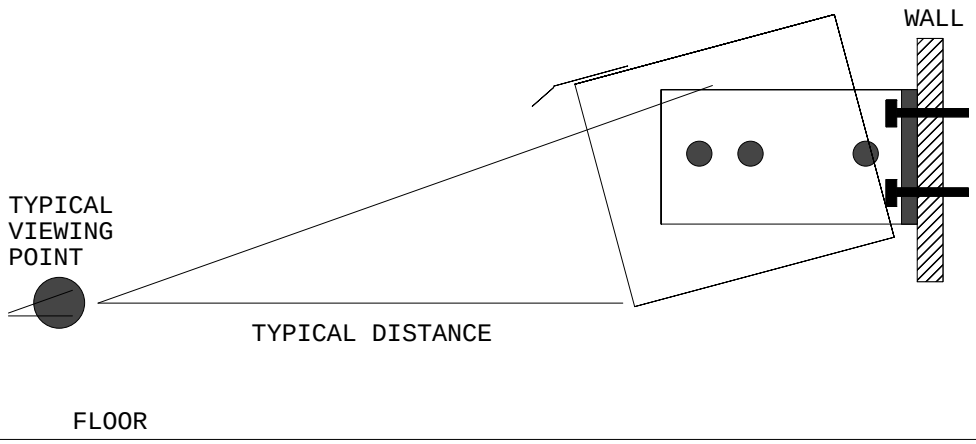
2.6. WALL MOUNTING

Each SM1000HWB Mounting Bracket can also be used to wall mount the Marquee Display. Use the middle hole to support the Marquee Display. The bent angle on the bracket has two holes for wall mounting.



First fasten the brackets to the Marquee Display, then locate the unit on the wall where it will be mounted and mark the holes that need drilling. Make sure that the mounting anchors you use can support the weight of your Marquee Display. Check the weight of the Marquee display in the specification tables. Once your mounting anchors are in place, reposition the Marquee Display and finish fastening the unit to the wall.

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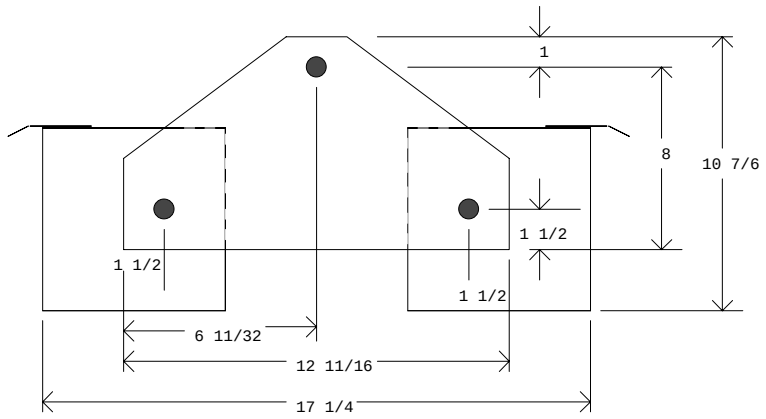
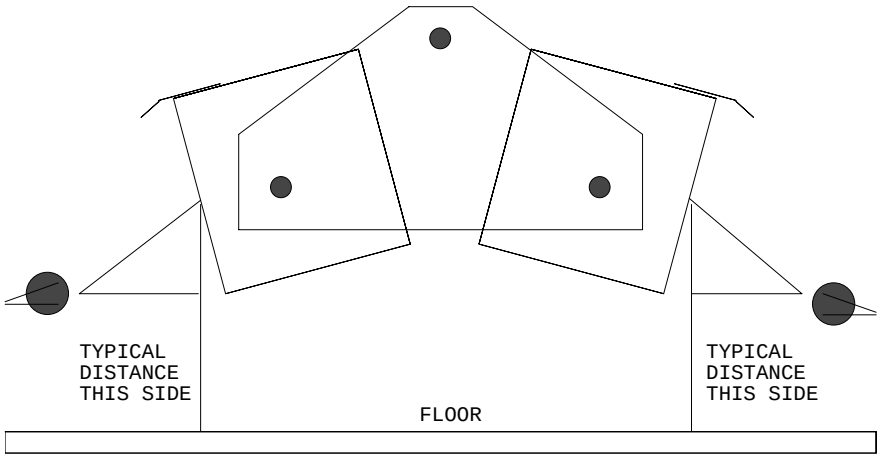
2.7. BACK TO BACK MOUNTING BRACKET

This bracket is an option which will allow hanging a pair of Marquee Displays from a single set of chains at a single location. The bracket is shown below.



SM1000BBB

For back to back installations match up the hole in one end of the bracket with the hole in the center of the Marquee Display end wall. Select the required viewing angle and tighten the bolt. Repeat the procedure for the other side of the first Marquee. Now repeat the entire procedure for the second Marquee Display. Remember the viewing angle for each side may be different, however, typically they will be the same.



Now the unit should be suspended with chains from the ceiling or building support structure. When selecting a mounting location be sure that there is sufficient support for your back to back Marquee Display. Check the weight of your Marquee Display from the specification table and multiply by 2.

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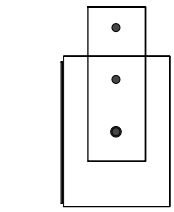
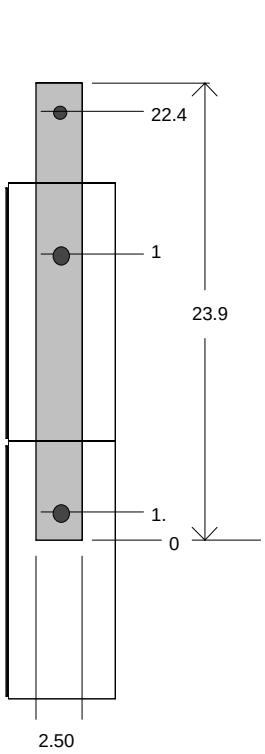
2.8. MULTIPLE UNIT BRACKETS

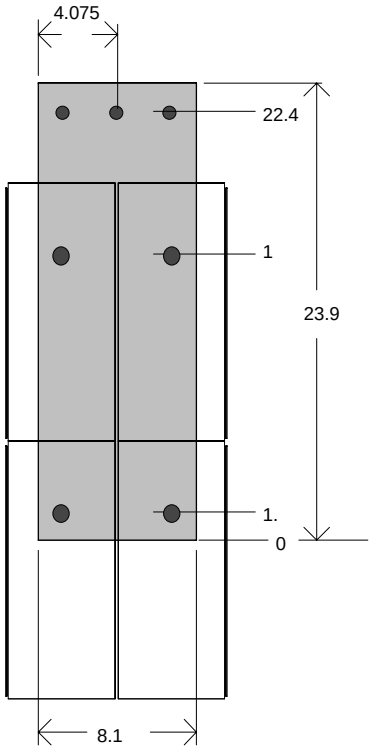
When you order a QM4204ROA Display, you will get two QM2204ROA units permanently stacked together. The display is hung using a stacked hanging bracket (SM1001SHB). A back-to-back configuration of two QM4204ROA Displays is hung using a back-to-back stacked hanging bracket(SM1001BSB). These two brackets are ONLY for hanging QM4204ROA Displays.



SINGLE BRACKET
SM1000HWB



STACKED HANGING BRACKET
FOR SM4204FOA DISPLAY
SM1001SHB



BACK-TO-BACK STACKED
HANGING BRACKET FOR
2 SM4204FOA DISPLAYS
SM1001BSB

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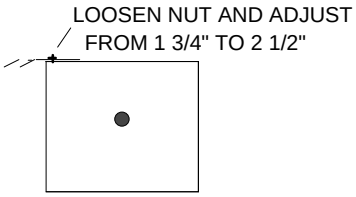
2.9. ADJUSTABLE GLARE VISOR

The adjustable glare visor allows the user to compensate for ambient light conditions. The darker the area in which the Marquee Display is mounted the greater the visibility. Keep in mind that direct sunlight or factory lighting that is at the same height as the Marquee Display will ``wash out'' the display and cause poor visibility.



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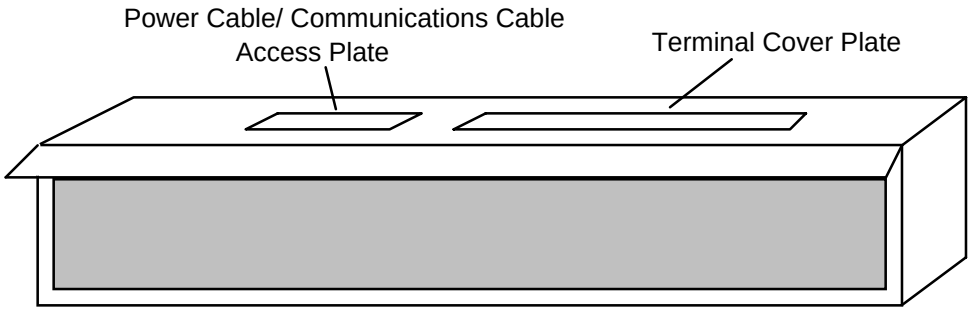
2.10. POWER CABLE/COMMUNICATIONS CABLE ACCESS PLATE

The power cable/communications cable access plate cover should be removed and then punched to accept raceway fittings that will terminate your cable runs. If your local plant/electrical codes allow, this fitting will terminate a flexible whip from your rigid power/communications wire runs.

The power cable must be installed according to local codes. Make sure your power source can support the total electrical load connected to it. Provide proper circuit protection and mechanical raceways. To make installation easier, plan on using a flexible raceway for the last three feet or longer if allowed by code. Also, leave at least three feet of wire pulled past the final fitting to allow dressing when connecting to the Marquee display terminal.

To gain access to the connection terminals, there are two cover plates (a large one and a small one) on the top of the Marquee Display.



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3. ELECTRICAL

3.1. GROUNDING

IMPORTANT!

When connecting a host device to one or more Marquee Displays it is very important to have each device connected to a common ground and common power supply. Good grounding cannot be over stressed. A complex system must have only one ground point for common power supplies and signal returns to prevent ground loops. We recommend Belden 9463 wire or other quality 22 gauge twisted shielded pair wire and connecting the shields to common ground at both ends of the wire.

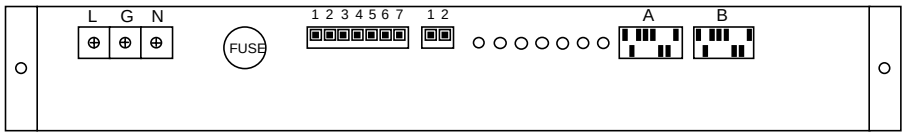
Proper grounding of the Display System will prevent symptoms that appear as malfunctions during normal "RUN" operation.

3.2. WIRE RUNS AND WIRING

DO NOT route control or data wires with power or high voltage wires other than Marquee power. Always use twisted shielded pair wire or Belden 9463 which provides a very effective shield against electrostatic and magnetic coupling.

3.3. ELECTRICAL CONNECTIONS

This section describes the electrical connections to the Marquee Display. The display should be tested prior to installing it in a permanent location. The following drawing shows the bracket containing the terminals and dip switches. This bracket if found inside the display, under the large terminal cover plate.



Use the information in this section to connect AC Power and host interface. Make the appropriate switch settings for the address, baud rate and character size. Once you

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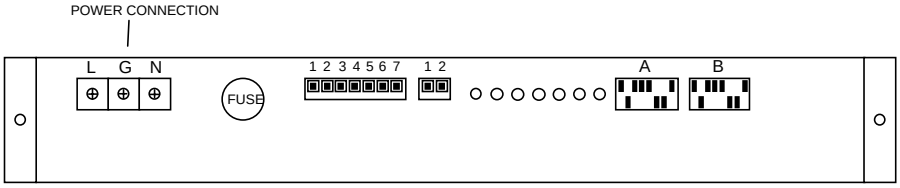
are sure all connections and settings are correct, turn on the power and watch the unit go through the self test cycle. When the self test has completed, the display will go blank and wait for commands from the host device.

3.4. CONNECTING AC POWER (TERMINALS L, G, N)

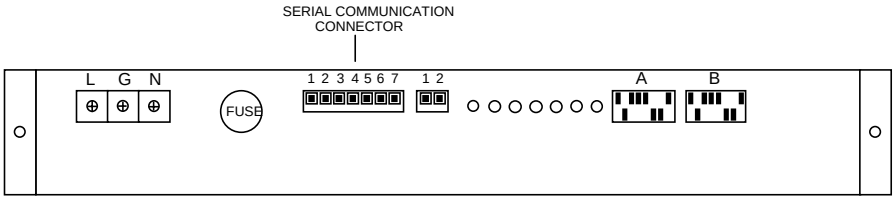
Connect the 115VAC hot lead to Terminal L. The neutral lead should be connected to Terminal N. Terminal G earth ground must be connected to a reliable low impedance path to protect the display from electrical noise. This ground connection will also protect personnel from electrical shock in case of equipment failure. The terminal strip is shown below.



Dress wires to the proper length and connect to a 115VAC +/- 10%, 47 to 63 Hz voltage source. The 115VAC supply line to the Marquee Display should have a 15 amp branch short circuit protection maximum.

3.5. SERIAL COMMUNICATION (TERMINALS 1-7)

The location of the serial communication connector is shown below. This connector is a pluggable 7 position terminal block which may be removed to facilitate wire connections.



3.6. RS232 CONNECTIONS (TERMINALS 1-3)

RS232 is the most common interface specification among controllers supporting serial communication. This specification allows connection of only one Marquee display, with a maximum recommended cable length of 50 feet. Consider using RS422/485 for applications that exceed these limitations. If you are connecting the Marquee Display to a Marquee Controller, the RS422 protocol will be used.

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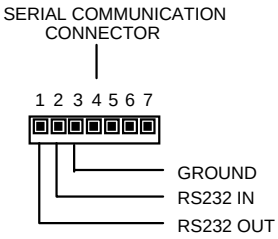
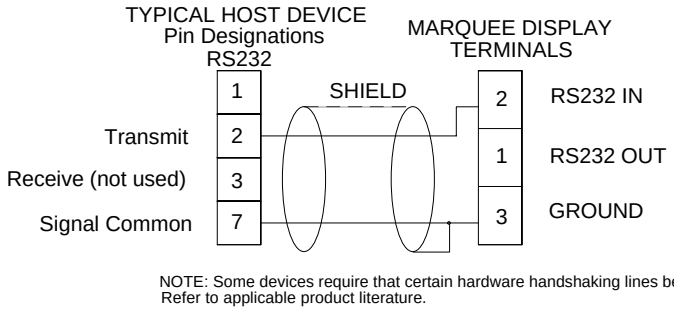


The Marquee Display's RS232 port does not support any hardware or software handshaking functions. Only the RS232 IN (Receive) terminal is used, along with the ground terminal.

The following shows a typical connection between a host device RS232 port and the Marquee display.

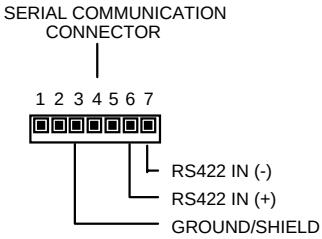


NOTE: Some devices require that certain hardware handshaking lines be asserted
Refer to applicable product literature.

It is generally recommended that the shield be connected at the display end only, as shown in the diagram above.

3.7. RS422/485 CONNECTIONS

Shown below are the location of the RS422 IN terminals on the serial communication connector.



Using an RS422/485 interface has the following advantages over RS232 specifications:

1. Improved noise immunity.
2. Marquee displays can be up to 10,000 feet (2 miles) from the host

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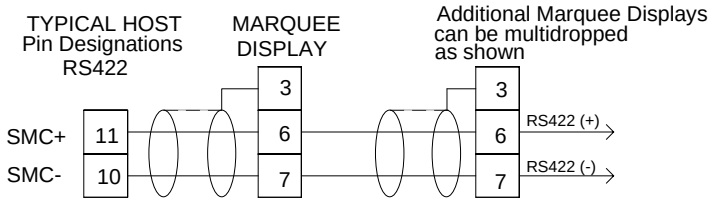
controller.

3. Up to 32 Marquee Displays can be connected directly to a host controller's RS422/485 port. 123 Marquee Displays can be addressed when line repeaters are used.

The Marquee Display's RS422/485 input port does not support any hardware or software handshaking functions.

The following diagram shows a typical RS422/485 connection to a Marquee display. This example shows the connection to the Marquee Controller (SM1000SMC).



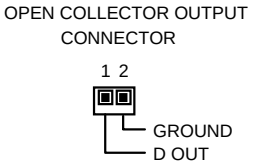
NOTE: Some devices require than certain hardware handshaking lines be asserted. Refer to applicable host device product literature.

The shield should be connected at one end only (either end is ok), as shown in the above diagram.

NOTE: The RS422 OUT port is not active and no connections should be made to this port.

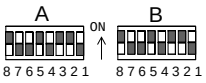
3.8. OPEN COLLECTOR OUTPUT

The Marquee Display is capable of controlling an open collector circuit that can drive a relay with up to 150 ma. at 24 VDC. A two position pluggable terminal strip is used to facilitate the connection. The relay should be connected to the terminal strip at terminal 1. A ground connection is provided at terminal 2 to establish a common ground with the power supply driving the relay.



3.9. DISPLAY CONFIGURATION (Switch A)

On power up, the Marquee Display will perform a number of functions in order to properly configure itself. The Marquee starts by displaying "AUTO CONFIGURING", at which point it is determining the number of displays that make up the complete sign. For example, a QM4204ROA is made up of 4 individual displays or lines. Further configuration is done through DIP switches labeled A and B:



The Marquee reads each bank of switches and configures its baud rate, character size, protocol and address accordingly. Below is the label that defines the settings for Switch A.

SWITCH 'A' CODES

BAUD RATE	2	1	CHAR. SIZE	4	3
300	OFF	OFF	2.1 ONLY	OFF	OFF
1200	OFF	ON	4.8 ONLY	OFF	ON
9600	ON	ON	2.1 & 4.8	ON	ON
19200	ON	OFF	4.8 SMC MODE	ON	OFF
PROTOCOL	**6**	**5**	**SELF TEST**	**8**	**7**
RSVD 1	OFF	OFF	TEST 1	OFF	OFF
RSVD 2	OFF	ON	TEST 2	OFF	ON
SLAVE	ON	ON	DISABLED	ON	ON
RSVD 3	ON	OFF	TEST 3	ON	OFF

Note: All switches set to the ON position is the default setting as set by the factory. This is the most common configuration. The user is advised not to change the settings unless specifically required by the application.

3.10.BAUD RATE SELECTION (Switch A)

On power up, the Marquee display will read the baud rate selected by switch bank A, switches 1 & 2 and display the selected baud rate during the power up display cycle.

The baud rate is selectable for 300, 1200, 9600 and 19200 Baud, as shown on the display label. The Baud rate is selected by changing switches 1 and 2 of switch bank A. The Baud rate table is shown below.

BAUD RATE	2	1
300	OFF	OFF
1200	OFF	ON
9600	ON	ON
19200	ON	OFF

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3.11.CHARACTER SIZE SELECTION (Switch A)

Four different character size settings exist for the Marquee. Unless you are using a multilined Marquee such as a QM4204ROA, the default setting (2.1" and 4.8" characters) should be selected. The character size settings are shown below.

CHAR. SIZE	4	3
2.1 ONLY	OFF	OFF
4.8 ONLY	OFF	ON
2.1 & 4.8	ON	ON
4.8 SMC MODE	ON	OFF

Why different character size settings? Their are two reasons for providing this feature. First, depending on the character size requirements of the application, the 2.1" ONLY and 4.8" ONLY settings may simplify the programming in the host device. Second, the different character size settings allow specific models of marquee displays to be compatible with specific devices. For example, when slaving a QM4204ROA marquee from a 4 line SMART SIM/MC or ALLEN BRADLEY DL20/DL40, it is necessary for the 4.8" ONLY character size setting to be selected.

Each character size setting affects the way the line number field in the slave protocol is interpreted. Below is a table containing these differences. See also the communications section of this manual.

FIELD 5 LINE #	2.1" ONLY	4.8" ONLY	4.8" SMC Mode	2.1" & 4.8"
Control A	Line 1	Line 1	Line 1	Line 1 - 2"
Control B	Line 2	Line 2	Line 2	Line 2 - 2"
Control C	Line 3	Line 3	-	Line 1 - 4.5"
Control D	Line 4	Line 4	Line 3	Line 3 - 2"
Control E	Line 5	Line 5	Line 4	Line 4 - 2"
Control G	Line 6	Line 6	-	Line 2 - 4.5"
Control H	Line 7	Line 7	-	Line 5 - 2"
Control I	Line 8	Line 8	-	Line 6 - 2"
Control K	-	-	-	Line 3 - 4.5"
Control L	-	-	-	Line 7 - 2"
Control N	-	-	-	Line 8 - 2"
Control O	-	-	-	Line 4 - 4.5"

When using the Marquee Controller, only use either 2.1" & 4.8" or 4.8" SMC MODE. This will insure compatibility with the Marquee Controller. Note: The 4.8" SMC MODE is the equivalent of LARGE MODE on the SMART Marquee displays.

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Refer to the applications section of this manual for further discussion on specific applications requiring the 2.1" ONLY and 4.8" ONLY character modes.

3.12.PROTOCOL SELECTION (Switch A)

Switches 5 and 6 control the protocol setting. The SLAVE protocol is the only protocol currently available. The remaining settings are reserved for future use. Below is the table for setting the protocol.

PROTOCOL	6	5
RSVD 1	OFF	OFF
RSVD 2	OFF	ON
SLAVE	ON	ON
RSVD 3	ON	OFF

3.13.SELF TEST SELECTION (Switch A)

Switches 7 and 8 control the self test setting. **These switches must both be set to on in order for the SLAVE protocol to operate normally.** The table below shows the self test settings. These tests are used by factory technicians to diagnose problems with the display. Contact the factory for assistance using this feature.

SELF TEST	8	7
TEST 1	OFF	OFF
TEST 2	OFF	ON
DISABLED	ON	ON
TEST 3	ON	OFF

TEST 1: Controller board production test.

TEST 2: Display burn-in test.

1. Test Blocks
2. Display Internal Temperature
3. Output On
4. Output Off
5. RS422 loopback.
6. RS232 loopback
7. Alpha port test
8. Failure report

TEST 3: Trouble shooting test determined by switch bank B.

1. Switch B = 1: Display character received on RS422 port.
2. Switch B = 2: Send characters out RS422 port.
3. Switch B = 3: Display AtoD number.
4. Switch B = 4: Turn output on.
5. Switch B = 5: Toggle output every 5 seconds.

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6. Switch B = 6: Run dipswitch test.
7. Switch B = 7: RS232 loopback.
8. Switch B = 8: RS422 loopback.
9. Switch B = 9: Alpha port test.
10. Switch B = 10: Watchdog test.

3.14.ADDRESS SELECTION (Switch B)

Upon power up, the Marquee Display will read the address selected by switch B and display that address during the power up display cycle.

The Marquee display address can be set from 1 to 127. Note that addresses: 0, 6, 10, 13, and 18 are reserved and would be interpreted as address 127:

Marquee display address 127 is a special slave address that will display all slave messages regardless of their address. Marquee display addresses need not be unique, a Marquee Display network may have two or more units with the same address as in the case of back to back units that display the same message on both sides.

The display label showing the address select table is shown below. Starting at address 1, the switch settings are selected using a binary format, with switch 7 being the most significant digit. Switch 8 is not currently used.

SWITCH 'B' CODES

ADDRESS	8	7	6	5	4	3	2	1
127	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
1	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON
2	OFF	OFF	OFF	OFF	OFF	OFF	ON	OFF
-	OFF	-	-	-	-	-	-	-
-	OFF	-	-	-	-	-	-	-
126	OFF	ON	ON	ON	ON	ON	ON	OFF
127	OFF	ON	ON	ON	ON	ON	ON	ON

ILLEGAL ADDRESSES 6, 10, 13, 18 & O
WILL DEFAULT TO 127 IF PROGRAMMED

3.15.FINAL CHECKS

After all the connections are made, including power and communications, the power should be applied and the unit tested for proper operation. If you change any switch setting, the power must be cycled in order for the new setting to be read.

Once proper operation has been established, the display is ready to install in a permanent location. See Section 2 for mechanical installation details.

The terminal cover plate should be securely fastened to the top of the Marquee Display to re-establish its NEMA 12/4 rating.

When the display is mounted in a permanent location, turn on the power and view the display. As part of the Marquee Display start-up, it will light up all display segments

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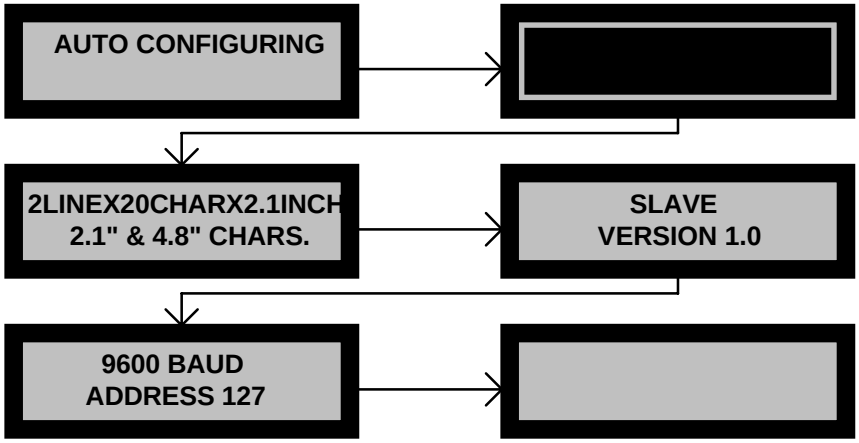
and execute a self test. The display will show which switch setting are selected. It will then go blank and wait for commands from the host device.

A sample self test is shown below.



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4. COMMUNICATION

4.1. INTRODUCTION

This section of the manual covers the slave protocol. The information in this section is presented using conventions that are defined as follows.

1. The "/" character is used to separate the fields of the protocol for the purpose of presenting the information and is not actually part of the protocol.
2. Words contained within the "<" and ">" symbols are not part of the protocol but references to the actual information to be substituted in place of the word and the symbols. For example, in place of <text>, one would put the actual message to be displayed.
3. The ASCII code for Control (CTRL) characters, Carriage Return and the ESCAPE character can be found in the Appendix section of this manual. Wherever ESCAPE or Control is used in the protocol, the equivalent ASCII code should be used. Do not use the characters that make up the word ESCAPE or Control.
4. Whenever applicable, the decimal representation of the ASCII code is provided in parenthesis. For example: A (65). The Appendix section of this manual contains a complete ASCII code table.

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4.2. SLAVE PROTOCOL FORMAT

All the information that creates a message must be formatted and sent by the host computer or programmable logic controller. Restrictions for the various fields are listed in each section. Samples are shown at the end of this chapter. The information packet that the host will transmit consists of the following packet:

Optional Control Character	250 Characters for Display	Optional Control Character	Device Address	Display Line Number	Carriage Return
FIELD 1	FIELD 2	FIELD 3	FIELD 4	FIELD 5	FIELD 6

Field 1 - optional control character header that establishes a functional command. Not used with Field 3.

Field 2 - can consist of any printable ASCII character

Field 3 - optional control character trailer that establishes a display mode. Not used with Field 1.

Field 4 - routes the message packet to the proper Marquee Display(s).

Field 5 - tells the Marquee Display on which line to display the message.

Field 6 - signifies the end of a data packet.

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4.3. FIELD 1 - HEADER CONTROL CHARACTERS FOR AUTO REPEAT

Optional Control Character	250 Characters for Display	Optional Control Character	Device Address	Display Line Number	Carriage Return
FIELD 1	FIELD 2	FIELD 3	FIELD 4	FIELD 5	FIELD 6

This field is not used with field 3.

The following AUTO REPEAT MODE allows messages to be downloaded into the Marquee and then left to run continuously. There is room for approximately 5000 bytes of message storage.

Control S - This command followed by a slave address, a don't care byte and a CR, will clear out the auto repeat buffer and if it is in the auto repeat mode, it will stop. It is a good idea to always start out with this command before downloading a new sequence of messages.

/CTRL S / <slave address> / <don't care> / carriage return

* Don't care bytes cannot be a CR, CTRL R, or CTRL F. We suggest sending the address again.

Control Y - This command will tell the slave marquee to add the following text field and mode control information to it's auto repeat memory. This string can be no longer than 255 bytes and also must be terminated with a slave number, a don't care byte, and a CR. (This is part of the 255 byte limitation.) A particular message can also be added to the buffer without breaking up the display flow, this is particularly useful for long scroll mode messages. The format is:

/CTRL Y / <text field> / <slave address> / <don't care> / carriage return

Control W - This command will enable the AUTO REPEAT mode. There are three modifiers that are associated with this command:

ASCII	DECIMAL	DEFINITION
0	48	Resume where stopped, even if its in the middle of a message. The message must be a line type message, not a roll or smooth scroll.
1	49	Resume at the beginning of a message run previous to stopping.
2	50	Start at the beginning of the buffer.

No modifier with this command is the same as using a 2 modifier. Again the message must contain an address, don't care byte, and a carriage return. The format is:

/ CTRL W / <modifier> / <slave address> / <don't care> / carriage return

This command can be used in conjunction with the stop command that is discussed next.

Control X - This command will stop the auto repeat mode without destroying the buffer's content, which will allow the unit to start up using CTRL W. This command is useful when an alarm message is to be posted. The auto repeat can be stopped and

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a regular message can be sent via the standard protocol. Then the auto repeat mode can be restarted. The format is:

/ CTRL X / <slave address> / <don't care> / carriage return

4.3.1. AUTO REPEAT - TEXT FIELD FORMAT

/CTRL Y / <text field> / <slave address> / <don't care> / carriage return

The text field that is sent to the display has it's own format to allow the display mode, line number and wait times to be changed throughout the message program. If the user simply sends text without any mode control codes, the display will default to line mode, line 1 and wait time of one second. To change the modes the following sequence must be sent before the text string in the text field;

1. An ESC (Escape) code and a ASCII T will tell the slave that the following data is meant to be a text string with attributes.

2. The line number will tell the slave what line the text is to be displayed on.

Line number is an ASCII character in the range of "0" (49) to "<" (60) and "O" (79).

ASCII	Decimal	2.1" ONLY	4.8" ONLY	4.8" SMC Mode	2.1" & 4.8"
0	48	All Line	All Line	All Line	All Line - 2.1"
1	49	Line 1	Line 1	Line 1	Line 1 - 2.1"
2	50	Line 2	Line 2	Line 2	Line 2 - 2.1"
3	51	Line 3	Line 3	-	Line 1 - 4.8"
4	52	Line 4	Line 4	Line 3	Line 3 - 2.1"
5	53	Line 5	Line 5	Line 4	Line 4 - 2.1"
6	54	Line 6	Line 6	-	Line 2 - 4.8"
7	55	Line 7	Line 7	-	Line 5 - 2.1"
8	56	Line 8	Line 8	-	Line 6 - 2.1"
9	57	-	-	-	Line 3 - 4.8"
:	58	-	-	-	Line 7 - 2.1"
;	59	-	-	-	Line 8 - 2.1"
<	60	-	-	-	Line 4 - 4.8"
O	79	All lines	All Lines	All Lines	All Line - 4.8"

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3. Display mode will tell how the text will be displayed.

Display mode is a ASCII value in the range of 0 (48) to 9 (57) and A (65) to C (67).

ASCII	Decimal	Display Mode
0	**48**	line mode
1	**49**	line mode
2	**50**	flash mode
3	**51**	smooth scroll mode
4	**52**	scroll up mode
5	**53**	scroll down mode
6	**54**	scroll right mode
7	**55**	scroll left mode
8	**56**	wipe up mode
9	**57**	wipe down mode
A	**65**	wipe left mode
B	**66**	wipe right mode
C	**67**	roll up mode

4. Wait time will tell the slave how long, in seconds, it should wait before starting the next message or the time between updating the display for multiple display messages.

Wait time is a ASCII two digit number that gives the delay time between updates of a line in a single line mode or all lines in all line mode. It can range from 0 (48) / 0 (48), to 9 (57) / 9 (57) seconds.

The format of the text field data is:

ESCAPE / T / line number / display mode / two byte wait time / text...../

The text is any printable ASCII character or variable field. The color switch is also allowed for use with the tricolor displays. In line mode, the lines of text will automatically be broken up and centered. Remember, this is the format for the text field, and is included as part of the whole message string.

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4.3.2. AUTO REPEAT - TEXT FIELD VARIABLE

The text field may also have an escape sequence embedded in it to signal that a variable is to be inserted there. The sequence is a ESCAPE (27) to tell the slave there is a field coming up, a V (86) to tell the slave a variable number is to follow, and an ASCII number from 0 (48) to 9 (57), which is the actual variable number that will be inserted at this point in the message program. The format is:

/ ESCAPE/ V / <ASCII digit 0 to 9> /

Where 0 to 9 is the variable number. The slave marquee variable can be a string of 32 displayable ASCII characters. There can be up to ten variables. If the message is being displayed that is to have a variable embedded but no variable exists, then nothing will appear in its place. The slave can be loaded with these variables independent of the auto repeat mode. To send over a variable, the sequence is as follows:

/CTRL V / <variable number (ASCII 0 to 9)> / <Text (up to 32 characters)>/ <address> / <don't care> / carriage return /

The variable feature allows users to send over messages that should remain constant but embedded with a message(s) that can change, i.e., time of day, temperature, parts count, etc.

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4.4. FIELD 2 - DISPLAYABLE CHARACTER FIELD

Optional Control Character	250 Characters for Display	Optional Control Character	Device Address	Display Line Number	Carriage Return
FIELD 1	FIELD 2	FIELD 3	FIELD 4	FIELD 5	FIELD 6

This field can contain up to 250 viewable characters. Any valid ASCII character, upper or lower case, can be sent. Control codes do not apply except for Control F Control R and Control U.

Control F will cause the characters of the entire string to flash. A second Control F will cancel the flash mode.

Control R is interpreted as a reset command and all data registers in the Marquee Display are cleared and you will be required to transmit new characters for display. In other words, if you were to send 10 characters, then a Control R, your previous 10 characters are lost and any following characters would be accepted by the Marquee Display. Control R also resets the flash status to not flashing. It is recommended that a Control R be sent to all Marquee displays when the host controller powers up, because when a serial port powers up it may inadvertently transmit erroneous data.

Control U has been added to allow changing the text color for tricolor displays. The format is as follows:

/Control U/ <color character>/

where,

<color character > = R (82) for red, G (71) for green and Y (89) for yellow.

The default color is red. This command can be used multiple times within the same text string.

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4.5. FIELD 3 - OPTIONAL TRAILER CONTROL CHARACTER

Optional Control Character	250 Characters for Display	Optional Control Character	Device Address	Display Line Number	Carriage Return
FIELD 1	FIELD 2	FIELD 3	FIELD 4	FIELD 5	FIELD 6

This field is not used with field 1.

This control character is optional and when sent to the Marquee display will be interpreted as a display mode. The following table lists the display mode operations.

Control A - Hold

Control B - Flash

Control C - Scroll

Control D - Scroll Up

Control E - Scroll Down

Control H - Scroll Right

Control I - Scroll Left

Control K - Wipe Up

Control L - Wipe Down

Control N - Wipe Left

Control O - Wipe Right

Control Q - Not Used

If no control character is sent in field 3 then the Marquee display will default to line mode operation.

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4.6. FIELD 4 - DEVICE ADDRESS

Optional Control Character	250 Characters for Display	Optional Control Character	Device Address	Display Line Number	Carriage Return
FIELD 1	FIELD 2	FIELD 3	FIELD 4	FIELD 5	FIELD 6

This is a one byte ASCII character ranging anywhere from 1 through 127 decimal (1 through 7F Hex). It should be noted that addresses 0, 6, 10, 13, and 18 are illegal addresses. Any Marquee display addressed as 127 will understand any data that is transmitted regardless of what the address is in the packet. In addition, any packet containing the address 127 is understood by all Marquee displays regardless of their addresses. This allows you to efficiently route a message to all displays. Multiple Marquee displays on an RS422/485 communication line can have the same address and they will all respond to a message sent to that address.

Remember, this field must be a ASCII character, not a decimal number. For example:

DEVICE ADDRESS (DECIMAL)	ASCII CHARACTER
1	CTRL-A
2	CTRL-B
11	CTRL-K
48	0 (ZERO)
68	D (Upper Case D)
102	f (Lower Case f)

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4.7. FIELD 5 - LINE NUMBER

Optional Control Character	250 Characters for Display	Optional Control Character	Device Address	Display Line Number	Carriage Return
FIELD 1	FIELD 2	FIELD 3	FIELD 4	FIELD 5	FIELD 6

This is a one byte ASCII character defined as 1, 2, 3, 4, 5, 7, 8, 9, 11, 12, 14, 15, 48, 49 or 50 decimal. The following table defines the line number results.

ASCII	**Decimal**	**2.1" ONLY**	**4.8" ONLY**	**4.8" SMC Mode**	**2.1" & 4.8"**
Control A	1	Line 1	Line 1	Line 1	Line 1 - 2.1"
Control B	2	Line 2	Line 2	Line 2	Line 2 - 2.1"
Control C	3	Line 3	Line 3	-	Line 1 - 4.8"
Control D	4	Line 4	Line 4	Line 3	Line 3 - 2.1"
Control E	5	Line 5	Line 5	Line 4	Line 4 - 2.1"
Control G	7	Line 6	Line 6	-	Line 2 - 4.8"
Control H	8	Line 7	Line 7	-	Line 5 - 2.1"
Control I	9	Line 8	Line 8	-	Line 6 - 2.1"
Control K	11	-	-	-	Line 3 - 4.8"
Control L	12	-	-	-	Line 7 - 2.1"
Control N	14	-	-	-	Line 8 - 2.1"
Control O	15	-	-	-	Line 4 - 4.8"
0	48	RELAY ON			
1	49	RELAY OFF			
2	50	BLANK ALL LINES			

Note that text contained in the text field will not be displayed when either 0 (48), 1 (49), or 2 (50) are used in the line number field.

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4.8. FIELD 6 - CARRIAGE RETURN

Optional Control Character	250 Characters for Display	Optional Control Character	Device Address	Display Line Number	Carriage Return
FIELD 1	FIELD 2	FIELD 3	FIELD 4	FIELD 5	FIELD 6

The carriage return defines an end of message and tells the Marquee Display to execute it and defines a starting point so that the Marquee Display can interpret each byte sent.

4.9. EXAMPLES

The following examples are intended for use with a Marquee Display set to the default character mode of 2.1" & 4.8" characters.

4.9.1. STANDARD FORMAT MESSAGES

The following format used by a Marquee Display is the simplest format and uses only four fields as shown below.

Optional Control Character	250 Characters for Display	Optional Control Character	Device Address	Display Line Number	Carriage Return
FIELD 1	FIELD 2	FIELD 3	FIELD 4	FIELD 5	FIELD 6
	Message 1		CTRL-A	CTRL-A	CTRL-M

In the above sample information packet, the device address is 1 (decimal) or ASCII CTRL-A. The character line selected to display the message is line 1 (decimal) or ASCII CTRL-A. The end of packet character is a CARRIAGE RETURN or ASCII CTRL-M.

Another information packet may contain a single optional control character, such as a control code to pulse the relay (CTRL-G). The format for this type of message is shown below.

Optional Control Character	250 Characters for Display	Optional Control Character	Device Address	Display Line Number	Carriage Return
FIELD 1	FIELD 2	FIELD 3	FIELD 4	FIELD 5	FIELD 6
CTRL-G			CTRL-A	CTRL-A	CTRL-M

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In the above example, the four control characters are sent out and cause the relay to pulse for .5 seconds. Control G (CTRL-G) is the command for pulsing the relay, the device address is 1 (decimal) or CTRL-A, the display line number is 1 (decimal) or CTRL-A, and finally the end of packet character, CTRL-M. Note that the display line number has no meaning in this message, but is still required as part of the format.

Another information packet may contain a message and a control character that defines the display mode, such as message flash or message scroll. The format is shown below.

Optional Control Character	250 Characters for Display	Optional Control Character	Device Address	Display Line Number	Carriage Return
FIELD 1	FIELD 2	FIELD 3	FIELD 4	FIELD 5	FIELD 6
	Message	CTRL-C	CTRL-B	CTRL-A	CTRL-M

In the previous example, the message would scroll on line 1 of display # 2. CTRL-C is the control character for scroll mode, the device address is 2 (decimal) or ASCII CTRL-B, the display line number is 1 (decimal) or ASCII CTRL-A, and the end of the packet character is CARRIAGE RETURN or CTRL-M.

In this example, the green color switch will be used. This information packet is intended for a tricolor display.

250 Characters for Display	Optional Control Character	Device Address	Display Line Number	Carriage Return
FIELD 2	FIELD 3	FIELD 4	FIELD 5	FIELD 6
CTRL-U G Green Message	CTRL-C	CTRL-B	CTRL-B	CTRL-M

4.9.2. AUTO REPEAT MESSAGES

In this example, the auto repeat buffer will be cleared.

Optional Control Character	250 Characters for Display	Optional Control Character	Device Address	Display Line Number	Carriage Return
FIELD 1	FIELD 2	FIELD 3	FIELD 4	FIELD 5	FIELD 6
CTRL-S			CTRL-A	CTRL-A	CTRL-M

The next example shows how to load the auto repeat buffer with a text message. In this example, the new message has no attributes sent with it, so the default settings are line mode, line 1 and wait time of 1 second.

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Optional Control Character	250 Characters for Display	Optional Control Character	Device Address	Display Line Number	Carriage Return
FIELD 1	FIELD 2	FIELD 3	FIELD 4	FIELD 5	FIELD 6
CTRL-Y	New Message		CTRL-A	CTRL-A	CTRL-M

The next example is used to enable the auto repeat buffer. Once this command is sent, the auto repeat buffer will start and continue to run. Note that there is a "0" in FIELD 3, which in this case is the command modifier to indicate that the message is to resume where it stopped.

Optional Control Character	250 Characters for Display	Optional Control Character	Device Address	Display Line Number	Carriage Return
FIELD 1	FIELD 2	FIELD 3	FIELD 4	FIELD 5	FIELD 6
CTRL-W	0		CTRL-A	CTRL-A	CTRL-M

The next example shows how to stop the auto repeat buffer.

Optional Control Character	250 Characters for Display	Optional Control Character	Device Address	Display Line Number	Carriage Return
FIELD 1	FIELD 2	FIELD 3	FIELD 4	FIELD 5	FIELD 6
CTRL-X			CTRL-A	CTRL-A	CTRL-M

In this next example, a new text message is downloaded to the display. The text field will have attributes that define the new message as 4.8" text in scroll mode, with a 3 second delay. The ESC T in front of the message indicates that the following codes will be attributes of the new message. The first 3 specifies 4.5" text size. The next 3 specifies smooth scroll mode. The last two characters, 03, specifies a 3 second delay.

Optional Control Character	250 Characters for Display	Optional Control Character	Device Address	Display Line Number	Carriage Return
FIELD 1	FIELD 2	FIELD 3	FIELD 4	FIELD 5	FIELD 6
CTRL-Y	<ESC>T3303New Message		CTRL-A	CTRL-A	CTRL-M

<ESC> = ESCAPE or the ASCII Character with a decimal value of (27).

The next example shows how to enter a message with an embedded variable into the auto repeat buffer. This variable is appended to the buffer. Whenever the auto repeat buffer is enabled, the variable will be displayed wherever the escape sequence is

encountered. If the variable has no characters, nothing will be displayed when the escape sequence is encountered.

Optional Control Character	250 Characters for Display	Optional Control Character	Device Address	Display Line Number	Carriage Return
FIELD 1	FIELD 2	FIELD 3	FIELD 4	FIELD 5	FIELD 6
CTRL-Y	Temperature = <ESC>V1 C		CTRL-A	CTRL-A	CTRL-M

Once the variable is entered in the buffer, the variable can be updated anytime by sending the following command. In this example, variable 1 is the text "400", and the full message "Temperature = 400 C" will be displayed when the buffer encounters escapes sequence 1.

Optional Control Character	Variable ID# (0-9)	250 Characters for Display	Optional Control Character	Device Address	Display Line Number	Carriage Return
FIELD 1		FIELD 2	FIELD 3	FIELD 4	FIELD 5	FIELD 6
CTRL-V	1	400		CTRL-A	CTRL-A	CTRL-M

Variables can be included with new messages, and multiple messages can be included in one command string. The last example shows two messages with different attributes, each followed by a variable.

CTRL-Y ESC T 3303 MESSAGE ONE ESC V 1 ESC T 1101 MESSAGE TWO ESC V 2 CTRL-A CTRL-A CTRL-M

Remember, ESC is the ESCAPE key. Don't type the letters.

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5. APPLICATIONS

5.1. HOST DEVICES

The Marquee Display can be a slave to many different host devices. In general, any device capable of formatting an ASCII character string that has either an RS232 or RS422 port is a suitable host device. Host devices can be divided into two categories, devices already designed to communicate with the Marquee Display and devices requiring additional programming.

An example of a device that would require programming to allow it to communicate with a Marquee Display is a personal computer or PC. A PC has the hardware necessary for communicating to a Marquee Display but lacks the user program to format and send the text strings. With a PC, a user is required to write a program in a language such as BASIC or C using the information provided in the Communications section of this manual.

Devices currently available that are capable of communication with the Marquee Display are listed below.

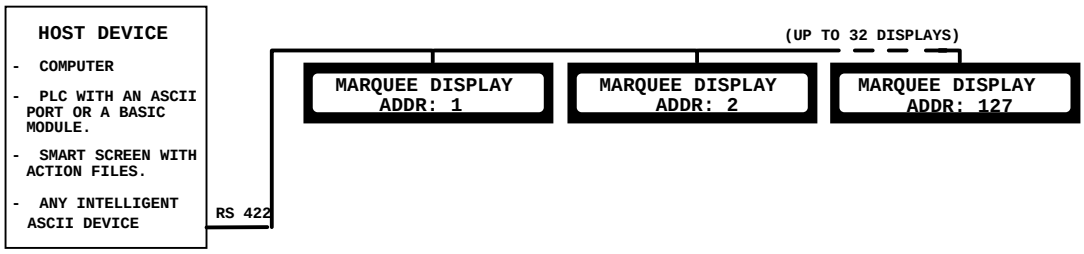
1) MARQUEE CONTROLLER: This product is design specifically for the Marquee Display and may be used with all models of Marquees.

2) SMART MC & SMART SIM Series Displays: These are panel mount displays that are capable of sending messages to a Marquee Display. Only certain models of the Marquee Displays may be used with these products.

3) ALLEN BRADLEY DL20 & DL40 Series Displays: These Allen-Bradley products are very similar to the SMART MC and SMART SIM products. Only certain models of Marquee Displays may be used with these products.

These devices are mainly designed for interfacing to PLCs (programmable logic controllers). The advantage to these devices is that they handle formatting and sending the text string to be displayed on the Marquee. All the user has to do is enter the messages into the unit and trigger it when required. Since these devices handle communications to the display, the user can skip the Communication section of this manual but must be sure to setup the display correctly as indicated in Electrical section. Specific applications involving this equipment are covered below.

5.2. HOST COMPUTER


HOST DEVICE
- COMPUTER
- PLC WITH AN ASCII PORT OR A BASIC MODULE.
- SMART SCREEN WITH ACTION FILES.
- ANY INTELLIGENT ASCII DEVICE
RS 422
(UP TO 32 DISPLAYS)
MARQUEE DISPLAY ADDR: 1
MARQUEE DISPLAY ADDR: 2
MARQUEE DISPLAY ADDR: 127

Many users choose to slave one or more Marquees from a host computer. Typical host computers are PCs, main frame systems or PLCs with a BASIC module or ASCII module. When slaving a Marquee from a host computer, it is required that the host computer store and format the messages to be displayed on the Marquee. To do this, a computer program must be created using the information presented in the Communications section of this manual. Depending on how elaborate the application, this may be accomplished with a simple BASIC program or may require a complex program in a more powerful programming language. Below is a sample basic program for displaying messages on a Marquee display.

```
REM      Sample BASIC program for sending messages to Marquee.
REM
REM      Select computers communication port.
CLS
INPUT "Communications Port (1 or 2): "; A$
IF A$ = "1" THEN OPEN "COM1;9600,N,8,1" AS #1
IF A$ = "2" THEN OPEN "COM2;9600,N,8,1" AS #1
IF A$ <> 1 AND A$<> "2" THEN CLS: END
REM
REM      Get users name.
CLS
INPUT "Enter your name: "; NAME$
REM
REM      Display name as simple line mode message.
REM      Format name for output to display using address 127 and line number 1.
PRINT #1, NAME$+CHR$(127)+CHR$(1)+CHR$(13);
REM
REM      Pause for 10 seconds.
T= TIMER+10
WHILE TIMER < T: WEND
REM
REM      Display message using auto repeat.
REM      Stop and clear buffer.
PRINT #1, CHR$(19)+CHR$(127)+CHR$(1)+CHR$(13);
REM
REM      Load name into auto repeat buffer; set display mode to smooth scroll; set
REM      line number to 1 and wait time to 2.
PRINT #1, CHR$(25)+CHR$(27)+"T1102"+NAME$+CHR$(127)+CHR$(1)+CHR$(13);
REM
REM      Start buffer
PRINT #1, CHR$(23)+"2"+CHR$(127)+CHR$(1)+CHR$(13);
REM
END
```

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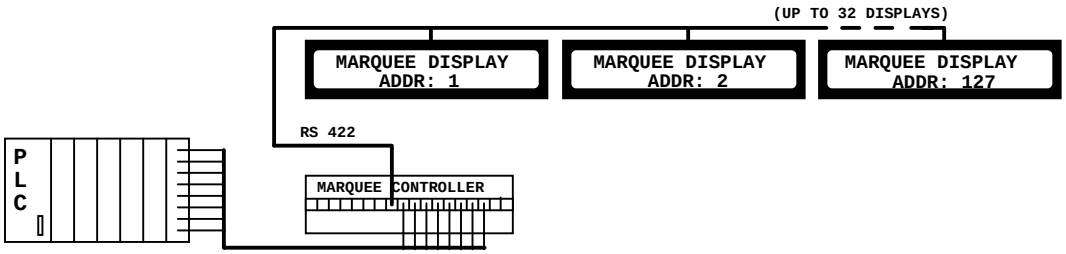
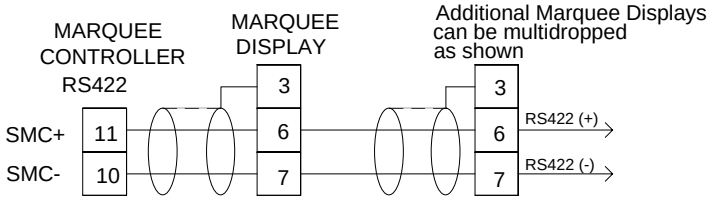
5.3. MARQUEE CONTROLLER



Marquee displays can be connected to the Total Control Products host device called a Marquee Controller (SM1000SMC). The Marquee Controller stores up to 1022 unique messages each with their own unique message attributes in its 31K of user memory.

The Marquee display(s) will be connected to the SMC- and SMC+ terminals of the Marquee Controller. Up to 32 Marquee Displays can be connected to the SMC- and SMC+ terminals with a maximum distance of 10,000 feet without the use of in line amplification. Using in-line RS422 amplification allows up to 123 separately addressable Marquee Displays to be connected to the SMC-, SMC+ terminals.

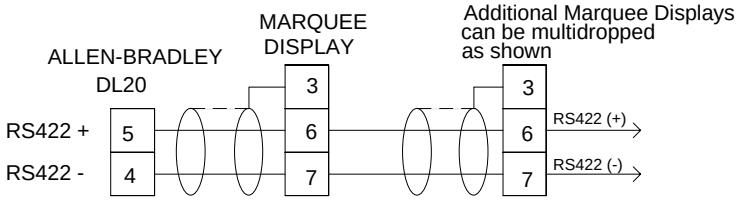


See the Marquee Controller User Manual (SM1000MMC) for more information.

5.4. ALLEN-BRADLEY DL20 & DL40 COMPATIBILITY

Marquee Displays can be connected to the Allen-Bradley Bulletin 2706 DL20 or DL40 Data Liner displays serial RS232 or RS422 port. Up to 32 Marquee Displays can be connected to the RS422 output port of the DL20 display at a maximum distance of 10,000 feet without the use of in-line amplification. Using in-line RS422 amplification allows up to 111 separately addressable Marquee Displays to be connected to the RS422 output of the Allen-Bradley DL20 without distance limitations.

Connect the Marquee Display to the RS422 output of the DL20 using a 100% shielded twisted pair cable with drain wire. Marquee address and baud rates must match those selected on the DL20 hardware and the ``out to slave" and correct ``slave number" must be programmed as message attributes. Also, be sure to select the correct character height on the Marquee. See the chart at the end of this section for setting the character mode.



Note that it is also possible to use the RS232 output of the DL20 to connect to one Marquee Display, however, the distance limitation is 50 feet.

When slaving a Marquee Display from a DL20 or DL40, Marquee selection is very important. Below is a chart showing which Marquee can be used for each Dataliner configuration.

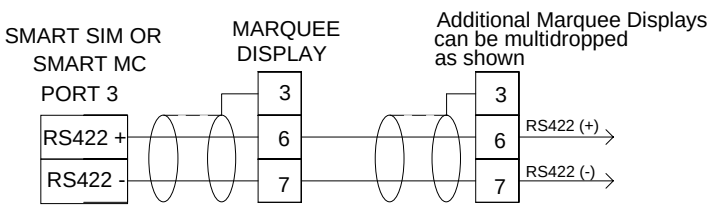
DATALINER # OF LINES	MARQUEE 2.1" CHAR. MODE	MARQUEE 4.8" CHAR. MODE
1	SM1202FOA	QM1204ROA
2	QM1104ROA	QM2204ROA
4	QM2104ROA	QM4204ROA

When using the Dataliner displays with a Marquee, avoid using scroll mode since this tends to slow the update time to the Marquee Display.

5.5. SMART SIM & SMART MC COMPATIBILITY

Marquee Displays can be connected to the SMART SIM or SMART MC displays serial RS232 or RS422 on port 3. Up to 32 Marquee Displays can be connected to the RS422 output port of the display at a maximum distance of 10,000 feet without the use of in-line amplification. Using in-line RS422 amplification allows up to 111 separately addressable Marquee Displays to be connected to the RS422 output without distance limitations.

Connect the Marquee Display to the port 3 RS422 output using a 100% shielded twisted pair cable with drain wire. Marquee address and baud rates must match those selected in the host display and the ``out to slave'' and correct ``slave number'' must be programmed as message attributes. Also, be sure to select the correct character height on the Marquee. See the chart at the end of this section for setting the character mode.



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Note that it is also possible to use the RS232 port 3 output of the SIM/MC to connect to one Marquee Display, however, the distance limitation is 50 feet.

When slaving a Marquee Display from a SIM or MC, Marquee selection is very important. Below is a chart showing which Marquee can be used for each display configuration.

SIM / MC # OF LINES	MARQUEE 2.1" CHAR. MODE	MARQUEE 4.8" CHAR. MODE
1	SM1202FOA	QM1204ROA
2	QM1104ROA	QM2204ROA
4	QM2104ROA	QM4204ROA

When using the SIM or MC with a Marquee, avoid using scroll mode since this tends to slow the update time to the Marquee Display.

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6. MAINTENANCE

6.1. CLEANING THE LENS

The lens should be cleaned using a soft cloth or paper towel and a non-abrasive cleaner. Avoid using industrial strength cleaners as they may react with the lens and cause the lens to blur the display.

6.2. FACTORY REPAIRS

This equipment has been tested and burned-in to reduce the occurrence of field failures. In the event you experience a problem with this unit, contact the customer service department for assistance. The phone number is located on the front cover of this manual. This unit is not field repairable and must be returned to the factory or authorized repair depot.

RETURN OF EQUIPMENT: UNDER NO CIRCUMSTANCES IS EQUIPMENT TO BE RETURNED WITHOUT FIRST OBTAINING PERMISSION AND A RETURN MATERIAL AUTHORIZATION NUMBER.

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APPENDIX A: ASCII CHARACTER CODE TABLE

Decimal	Oct.	Hex	Binary	Printed Character	Control Code
0	000	00	00000000	NUL	CTRL 0
1	001	01	00000001	SOH	CTRL A
2	002	02	00000010	STX	CTRL B
3	003	03	00000011	ETX	CTRL C
4	004	04	00000100	EOT	CTRL D
5	005	05	00000101	ENQ	CTRL E
6	006	06	00000110	ACK	CTRL F
7	007	07	00000111	BEL	CTRL G
8	010	08	00001000	BS	CTRL H
9	011	09	00001001	HT	CTRL I
10	012	0A	00001010	LF	CTRL J
11	013	0B	00001011	VT	CTRL K
12	014	0C	00001100	FF	CTRL L
13	015	0D	00001101	CR	CTRL M
14	016	0E	00001110	SO	CTRL N
15	017	0F	00001111	SI	CTRL O
16	020	10	00010000	DLE	CTRL P
17	021	11	00010001	DC1	CTRL Q
18	022	12	00010010	DC2	CTRL R
19	023	13	00010011	DC3	CTRL S
20	024	14	00010100	DC4	CTRL T
21	025	15	00010101	NAK	CTRL U
22	026	16	00010110	SYN	CTRL V
23	027	17	00010111	ETB	CTRL W
24	030	18	00011000	CAN	CTRL X
25	031	19	00011001	EM	CTRL Y
26	032	1A	00011010	SUB	CTRL Z
27	033	1B	00011011	ESC	Escape
28	034	1C	00011100	FS	CTRL ,
29	035	1D	00011101	GS	CTRL -
30	036	1E	00011110	RS	CTRL .
31	037	1F	00011111	US	CTRL /
32	040	20	00100000	SP	
33	041	21	00100001	!	
34	042	22	00100010	"	
35	043	23	00100011	#	
36	044	24	00100100	$	
37	045	25	00100101	%	
38	046	26	00100110	&	
39	047	27	00100111	'	
40	050	28	00101000	)	
41	051	29	00101001	(	
42	052	2A	00101010	*	
43	053	2B	00101011	+	
44	054	2C	00101100	,	
45	055	2D	00101101	-	
46	056	2E	00101110	.	
47	057	2F	00101111	/	
48	060	30	00110000	0	
49	061	31	00110001	1	
50	062	32	00110010	2	

Decimal	Oct.	Hex	Binary	Printed Character	Control Code
51	063	33	00110011	3	
52	064	34	00110100	4	
53	065	35	00110101	5	
54	066	36	00110110	6	
55	067	37	00110111	7	
56	070	38	00111000	8	
57	071	39	00111001	9	
58	072	3A	00111010	:	
59	073	3B	00111011	;	
60	074	3C	00111100	<	
61	075	3D	00111101	=	
62	076	3E	00111110	>	
63	077	3F	00111111	?	
64	100	40	01000000	@	
65	101	41	01000001	A	
66	102	42	01000010	B	
67	103	43	01000011	C	
68	104	44	01000100	D	
69	105	45	01000101	E	
70	106	46	01000110	F	
71	107	47	01000111	G	
72	110	48	01001000	H	
73	111	49	01001001	I	
74	112	4A	01001010	J	
75	113	4B	01001011	K	
76	114	4C	01001100	L	
77	115	4D	01001101	M	
78	116	4E	01001110	N	
79	117	4F	01001111	O	
80	120	50	01010000	P	
81	121	51	01010001	Q	
82	122	52	01010010	R	
83	123	53	01010011	S	
84	124	54	01010100	T	
85	125	55	01010101	U	
86	126	56	01010110	V	
87	127	57	01010111	W	
88	130	58	01011000	X	
89	131	59	01011001	Y	
90	132	5A	01011010	Z	
91	133	5B	01011011	[	
92	134	5C	01011100	\	
93	135	5D	01011101	]	
94	136	5E	01011110	^	
95	137	5F	01011111	_	
96	140	60	01100000	\	
97	141	61	01100001	a	
98	142	62	01100010	b	
99	143	63	01100011	c	
100	144	64	01100100	d	

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Decimal	Oct.	Hex	Binary	Printed Character	Control Code
101	145	65	01100101	e	
102	146	66	01100110	f	
103	147	67	01100111	g	
104	150	68	01101000	h	
105	151	69	01101001	i	
106	152	6A	01101010	j	
107	153	6B	01101011	k	
108	154	6C	01101100	l	
109	155	6D	01101101	m	
110	156	6E	01101110	n	
111	157	6F	01101111	o	
112	160	70	01110000	p	
113	161	71	01110001	q	
114	162	72	01110010	r	
115	163	73	01110011	s	
116	164	74	01110100	t	
117	165	75	01110101	u	
118	166	76	01110110	v	
119	167	77	01110111	w	
120	170	78	01111000	x	
121	171	79	01111001	y	
122	172	7A	01111010	z	
123	173	7B	01111011	{	
124	174	7C	01111100	|	
125	175	7D	01111101	}	
126	176	7E	01111110	~	
127	177	7F	01111111	DEL	